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MODELLING COMBAT AS A SERIES OF MINI-BATTLES

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MODELLING COMBAT AS A SERIES OF MINIBATTLES

1. This is the third interim report on the study investigating the feasibility of modelling battalion level combat as a series of minibattles sponsored by the US Army Research,Development and Standardisation Group (UK) under contract number DAJA45-86-C-0053.The work is also sponsored by the Directorate of Science (Land) (D.Sc(L)) of the UK Ministry of Defence under contract number D/ER1/9/4/2004/02/DSc(L).

OBJECTIVE OF THE STUDY

2. The current interest in network battle modelling arose from the analysis of the trial ' CHINESE EYE III ',[A,B] carried out by David Rowland and others at the UK Defence Operational Analysis Establishment (DOAE).The objective of the current investigation is to assess the utility of the networking concept as the basis for a model of battalion level combat.Such a model could be designed to be fast running and easy to set up - like many current highly aggregated Lanchester based models - and at the same time provide a more detailed and accurate representation of combat than is currently possible in Lanchester based models.

3. The original study proposal envisaged that the structure of the programme of work would be as follows:

a. the collection and analysis of data,

b. derivation of an appropriate methodology for generating networks,

c. the investigation of attrition methodologies,

d. development and verification of a combat model, and

e. validation and assessment of the model.

This report will discuss progress to date in each of these aspects, and outline the proposed programme of future work.

DATA COLLECTION AND ANALYSIS

4. The objectives of this part of the study are twofold :

a. To establish the relationship - if any - between network structure and the terrain, mix of forces and tactics employed.

b. To assess the sensitivity of network structure to changes in the rules used to derive the network.

To this end, analysis of data from the Chinese Eye III trial [C] is now complete, and analysis of data from the ARCOM8 trials held at Fort Hood, Texas - which we received in mid-July - is proceeding.

METHODOLOGY FOR GENERATING A NETWORK.

6. The methodology adopted for generating a network is obviously dependent on the results of the above analysis,and will also influence the structure of the minibattle model.At an early stage,two possible methods for generating the network were being considered :

   a. the use of a predetermined network,

   b. the use of a highly aggregated statistical method.

7. The first of these approaches is currently being studied. The structure of such a network will depend on the properties of the terrain with respect to movement and line of sight,and also on the way in which both sides use their forces.

8. Any network based combat model will therefore require some representation of the terrain over which the battle is fought,and of the tactics employed.As a degree of aggregation is required,a concept akin to that of scenario primitives in the model ELAN might provide an appropriate terrain/tactical representation and thus form the basis for a model.This is currently under investigation.

9. In addition,the effects of changing the attrition methodology in an existing combat model (SLEW - developed at RMCS) from

an Exponential Lanchester method to a network based approach is under investigation,the objective being to determine the benefits which accrue,in terms of accuracy and flexibility, from using the networking concept.

10. The use of an aggregated statistical network model is effectively precluded by the absence of relevant data.However any predetermined network model will inevitably have some statistical component.

ATTRITION METHODOLOGY

11. In a network based combat model,the forces will fight a number of small engagements and it is therefore important to use an attrition methodology appropriate to small force-on-force engagements.

12. The work of Ancker and Gafarian [D,E,F] has shown conclusively that conventional exponential (stochastic) and deterministic Lanchester models are inappropriate for modelling engagements with relatively few combatants.The requirement for a fast running model effectively eliminates the possibility of using a simulation to model the minibattles,and so the remaining possibilities are

a. Use of an extended model based on the Lanchester theory.

b. Use of approximate methods to obtain solutions to the m vs. n stochastic duel.

13. Initially,a model was developed based on an 'extended state space' version of the exponential Lanchester equations,the intention being to take separate account of the detection process,which is either ignored or incorporated in the kill rate in conventional Lanchester models.This approach has produced some promising results when compared with simulations using Erlang interfiring times,although the duration of the battle is underestimated by the model.Further work is in progress in this area,with the objective of determining the validity of this approach in the more general case.In addition,the feasibility of extending the method to larger state spaces is being considered.

14. The use of approximate methods to obtain solutions to the general stochastic duel are currently being investigated by Gafarian at the University of Southern California (USC) under US Army sponsorship.The main method being considered at USC is the use of an inhomogeneous Poisson Process approximation. It may also be feasible to apply entropy maximisation techniques - which have been used extensively in the analysis of queueing problems - to this problem.This of these possibilities is being pursued at RMCS,although useful results are not expected to emerge until early 1988.

DEVELOPMENT OF A COMBAT MODEL

15. Some relevant points have been discussed in sections 7,8,9.

16. A simple networked combat model has been developed to assess the effect of structuring a battalion level battle as a series minibattles.The model uses the modified exponential Lanchester methodology described above to resolve combat at each node of the network.

17. The model is currently being used to study the effect of varying network parameters (such as number of nodes, number of links) on the outcome of the battle.Some conclusions which can be drawn from this work are :

    a. The networked combat approach gives very different results from those produced by conventional Lanchester models,particularly where the less numerous side has an advantage at individual weapon level.

    b. The most significant network parameters in determining the outcome of the battle appear to be the number of nodes and the ratio of the number of nodes to the number of links in the network.

    c. The terminating conditions for each minibattle also have a significant influence on the overall outcome of the battle.

18. The work has not yet progressed to a point where there is a working combat model to be validated and assessed as a study tool.

FUTURE WORK

19. The future work programme will include :

a. The continuing analysis of data from the ARCOMS trials.

b. Based on the results of the data analysis,the development of software to generate battle networks a given scenario and terrain.

c. Investigation of the effects of decomposing existing force-on-force models - for example ELAN (TRAC) or SLEW (RMCS) - into a series of *minibattles* within a range or time frame.

d. The further investigation of the extended state space exponential Lanchester attrition methodology to determine the range of combat situations which can be satisfactorily modelled using this technique.

e. The assessment of alternative attrition methodologies.

f. The effect of varying combat parameters,such as the average force ratio,on the results from predetermined network models,and comparison of these with results from

equivalent force on force models.

In addition,if data from a model such as JANUS-T were to become available,this would allow the effect of basing network structure on lines of sight and arcs of responsibility, as opposed to on engagements between weapons,to be assessed. The completion of the above tasks will allow the development of a more sophisticated and generalised version of the existing network combat model.

CONCLUSIONS

20. Progress is being made in each component of the work programme and a number of models and tools have developed to investigate different aspects of the work.Funding for this research has now been extended until September 1988,and the final technical report is now due in November 1988.

REFERENCES

A. Rowland D.,' The Local Anti-Armour Density Necessary to Defeat a WP Attack ',classified UK CONFIDENTIAL,DOAE Note Number 800/200 April 1981.

B. Rowland O.,' Field Trials and Modelling ',paper presented to the International Symposium on Advances in Combat Modelling,held at RMCS,Shrivenham,Swindon,UK, 4 - 7 September 1984.

C. Rowland O. and Weeks A.L.P. ,' A Tactical Account of Exercise CHINESE EYE III ',classified UK RESTRICTED, DOAE Memorandum Number 76121 July 1976.

D. Ancker C. and Gafarian A.,' The Validity of Assumptions Underlying Current Uses of Lanchester's Attrition Rates ', paper presented to the International Symposium on Advances in Combat Modeling,held at RMCS,Shrivenham, Swindon,UK,4 - 7 September 1984.

E. Ancker C. and Gafarian A.,' The Two on One Stochastic Duel ',Naval Research Logistics Quarterly,Vol. 31 pp. 309 - 324 (1984).

F. Gafarian A. and Manion K.,' The Two on Two Stochastic Duel ',to be published in Naval Research Logistics Quarterly.